BRIEFER ARTICLES.

NOTES ON THE PHYSIOLOGY OF STIGEOCLONIUM.

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY. LXX.

(WITH THREE FIGURES)

THE experiments with which this paper has to deal fall into two groups, those with low temperatures and those with sea water. The subject for experimentation was the polymorphic form of Stigeoclonium with which I have been concerned in several preceding papers.[1] As has been already shown, this alga takes either of two very distinct forms according to the nature of the medium in which it is grown. In solutions of relatively high osmotic pressure and in those of low pressure to which stimulating metallic salts have been added, the palmella form is assumed. This consists of nearly spherical cells lying singly or in irregular groups. In unpoisoned solutions of low osmotic pressure the alga grows as branching filaments composed of cylindrical cells. When such filaments are placed in a poisoned solution or in one of high pressure, they become transformed to the other form by the simple rounding off of their individual cells. In general the production of zoospores is checked where the palmella form is produced, but there are a number of exceptions to this among the metallic poisons.[2] In such cases this process may be accelerated even where the germination and growth of the zoospores are inhibited.

I. *Low temperatures.*—Since high pressure of the medium acts to prevent water absorption, and since low temperatures are known to cause the extrusion of water by both plant and animal cells,[3] it occurred to me that

[1] LIVINGSTON, B. E., (1) On the nature of the stimulus which causes the change in form of polymorphic green algae. BOT. GAZETTE **30**:289–317. 1900.

———, (2) Further notes on the physiology of polymorphism in green algae. BOT. GAZETTE **32**:292–302. 1901.

———, (3) The rôle of diffusion and osmotic pressure in plants. Chicago. 1903. Part II, Chapter III. This chapter was reprinted as "The effect of the osmotic pressure of the medium upon the growth and reproduction of organisms. Chicago. 1903.

———, (4) Chemical stimulation of a green alga, Bull. Torr. Bot. Club **32**:1–34. *figs. 17.* 1905.

[2] Loc. cit. (4).

[3] Loc. cit. (3), pp. 75 and 141, and the references there given.

possibly low temperatures might also cause filaments of this alga to take the palmella form. Experiments were devised to test this point, and their results are here given.

Cultures of the filamentous form were made in small glass dishes with loosely fitting covers. The medium employed was the modification of Knop's solution previously described,[4] and had an osmotic pressure of 60^{mm} of mercury. The culture dishes were placed in weighted beakers which floated about three-fourths immersed in ice-water contained in a galvanized iron tank. Ice was added from time to time as melting took place, and the superfluous water was drawn off. The tank was covered with glass and stood in the conservatory, so that the plants were supplied with the necessary light for growth. The cultures were shaded from direct sunlight.

In the medium employed the alga grows rapidly as filaments at laboratory and conservatory temperatures. Zoospores are produced and germinate to form new filaments. Such normal filaments are shown in *fig. 2*. The figures are all from camera drawings and are magnified about 300 diameters. In the cold cultures, whose temperature rarely rose above 6° C.,[5] the growth of the original filaments was checked, but the production of zoospores continued at about the normal rate. At the end of fifteen days the old filaments had completely changed to the palmella form, in the manner already described for solutions of high osmotic pressure. Zoospores fail to germinate normally in the cold; most of them simply lie quiescent on the bottom of the dish, having assumed the spherical form, while a few enlarge slowly and divide into new palmella cells. Growth of the palmella form is comparatively very slow at ordinary temperatures. It is still more so in the cold, and this retardation is here even more marked in resting zoospores than in cells produced by the breaking up of the original filaments. Palmella cells from one of the cold cultures are shown in *fig. 1*. They are seen to be exactly similar to those produced by high pressure or toxic cations. Several resting zoospores and empty sporangia are also figured. That the plant was not permanently injured by the low temperature was shown conclusively by continuing the cultures in the conservatory after they had been taken from the cold bath. They all responded to the return to normal temperature, by producing typical filaments in from ten to fourteen days. A portion of one of these cultures after the filamentous form had been assumed again is shown in *fig. 2*. Germinating zoospores and empty sporangia are also shown.

[4] Loc. cit. (4), p. 4.

[5] During the period of the experiment, 20 days, the temperature was unwittingly allowed to approach 10° C. several times, for periods of a few hours only.

Five cultures made from different stock material, and always compared with controls maintained at the temperature of the conservatory, all agreed perfectly in the results. Thus it seems safe to conclude that *low temperatures act upon the vegetative growth of this alga with the same result as do high osmotic pressure and poison cations.* No acceleration of zoospore formation, a phenomenon often exhibited in poisoned solutions, has been observed here. It appears that in low temperature we have another method of withholding water from the plant, and that the uniform response to such withholding is the production of the palmella form.[6]

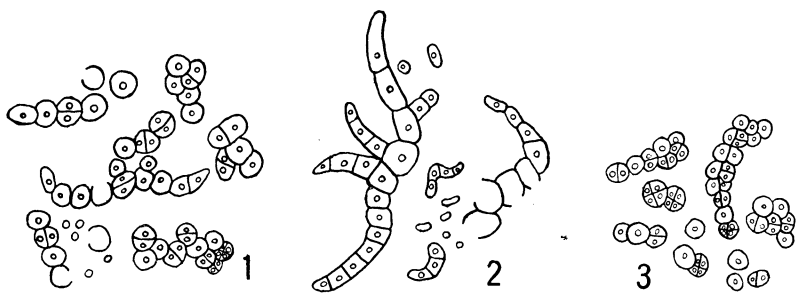

FIG. 1.—Palmella from filaments like *fig. 2* in culture at low temperature.

FIG. 2.—Normal filaments and germinating zoospores from cold palmella culture returned to normal temperature.

FIG. 3.—Palmella in sea water from normal filaments like *fig. 2.*

II. *Sea water.*—During my residence at the New York Botanical Garden I was able to determine the behavior of this Stigeoclonium in sea water. Natural water was collected from the surf at Far Rockaway, L. I., and was brought in bottles to the laboratory, where it was used in making the cultures. Filaments of this plant placed in undiluted sea water take the typical palmella form, as in other solutions of high pressure. Zoospores are not produced, nor do those produced previously germinate. Such a culture is shown in *fig. 3.* The water used had a pressure of about 25,000^{mm} of mercury.[7] In sea water diluted to one-tenth and one-hundredth of its natural concentration respectively—water redistilled in glass being used in the dilution—the response is the same, although the change is not so rapid. In the latter dilution it seems impossible that osmotic pressure is the main stimulating factor, for here is a pressure of only about 250^{mm}

[6] See the remarks on this subject in the paper on chemical stimulation, loc. cit. (4), p. 21 et seq.

[7] The calculation was made by the method of the depression of the freezing-point, loc. cit. (3), p. 37.

of mercury, while a pressure of over 15,000^{mm} is necessary to bring about a marked response in the alga.[8] Perhaps there is a stimulating chemical in sea water which aids the somewhat high osmotic pressure to bring about the result. At a dilution of one-thousandth the filaments grow normally as in weak nutrient solutions.

The result of this test suggests how a fresh-water form coming into sea water may be influenced to change its character and still live and thrive. This may have been a factor in the evolution of certain algal forms.—BURTON EDWARD LIVINGSTON, *The University of Chicago.*

FERTILIZATION IN THE SAPROLEGNIALES.

PROFESSOR B. M. DAVIS,[9] in his criticism of my views "On fertilization in the Saprolegnieae," makes use of the term "ovocentrum" in a sense very different from that which I gave to it. His use of the term, moreover, is obviously based on a misconception of my meaning. He says "TROW calls the egg-asters ovocentra." I neither do this, nor do I approve of it being done. Such an innovation would be worse than useless, as it would increase the confusion which already exists. At present, unfortunately, structures of more than one kind have apparently been grouped together by giving them a common name—"coenocentrum." I suggested the term "ovocentrum" as suitable for use in describing the dense mass of protoplasm found at the center of the eggs of the Saprolegnieae. Imbedded in the ovocentrum of an egg I find a single nucleus accompanied by a single centrosome and its astrosphere. It would have been correct, I think, for DAVIS to have said that the "coenocentra" discovered by him in Saprolegnia were interpreted by me—rightly or wrongly—as consisting of centrosomes with their astrospheres. The "ovocentra" of the Saprolegnieae may be the equivalents of the coenocentra of the Peronosporeae. They are altogether different from centrosomes and astrospheres. I cannot, therefore, accept DAVIS'S statement that I call "the egg-asters ovocentra." I do not propose to discuss the many other points of interest raised by Professor DAVIS, for new facts are required now, and these can only be obtained by patient and prolonged investigation in the laboratory.—A. H. TROW, *Cardiff, Wales.*

[8] Loc. cit. (1) and (2). [9] BOT. GAZETTE **39**:61. 1905.